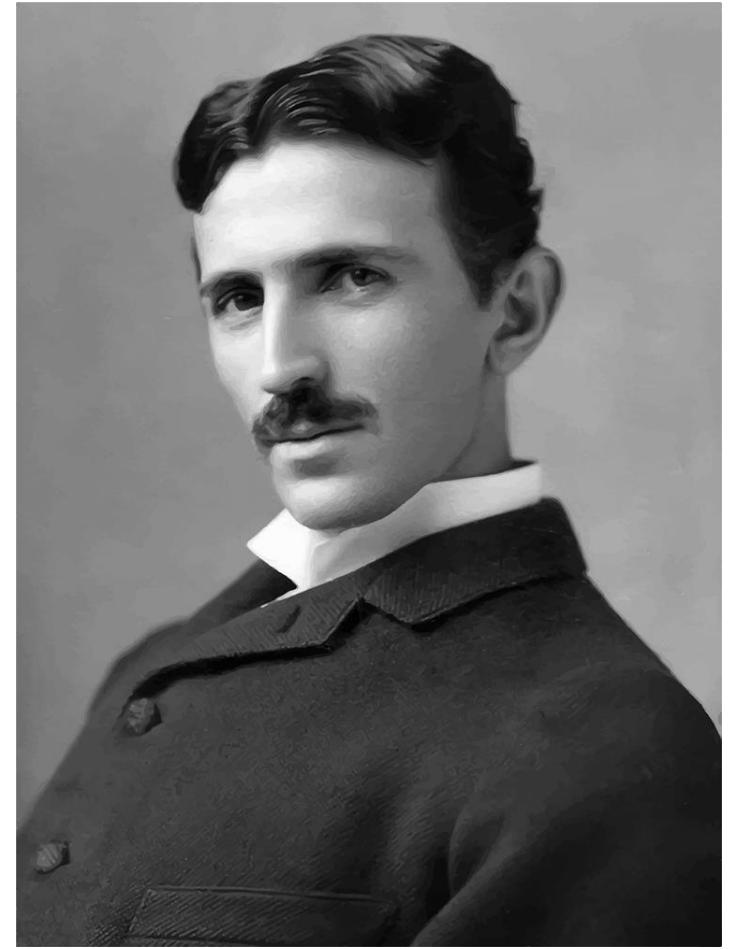




NIKOLA TESLA

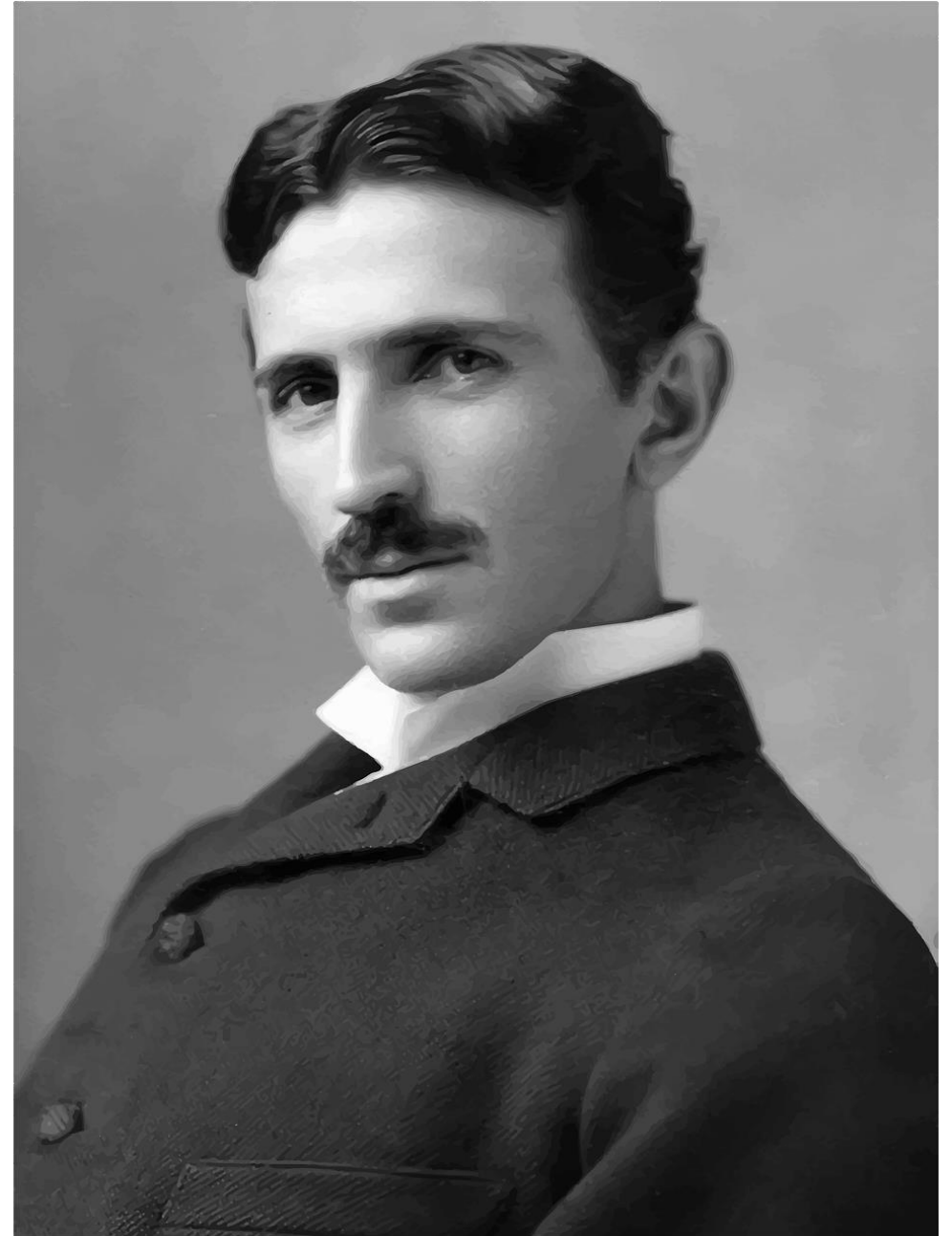
Born and raised in the Austrian Empire, Tesla first studied engineering and physics in the 1870s without receiving a degree.

Nikola Tesla (10 July 1856 – 7 January 1943) was a Serbian-American engineer, futurist, and inventor. He is known for his contributions to the design of the modern alternating current (AC) electricity supply system.

Born and raised in the Austrian Empire, Tesla first studied engineering and physics in the 1870s without receiving a degree. He then gained practical experience in the early 1880s working in telephony and at Continental Edison in the new electric power industry.

In 1884 he immigrated to the United States, where he became a naturalized citizen. He worked for a short time at the Edison Machine Works in New York City before he struck out on his own.

Tesla obtained around 300 patents worldwide for his inventions.





Tesla's father, Milutin, was an Orthodox priest in the village of Smiljan.

Nikola Tesla was born into an ethnic Serb family in the village of Smiljan, within the Military Frontier, in the Austrian Empire (present-day Croatia), on 10 July 1856. His father, Milutin Tesla (1819–1879), was a priest of the Eastern Orthodox Church. His father's brother Josif was a lecturer at a military academy who wrote several textbooks on mathematics.

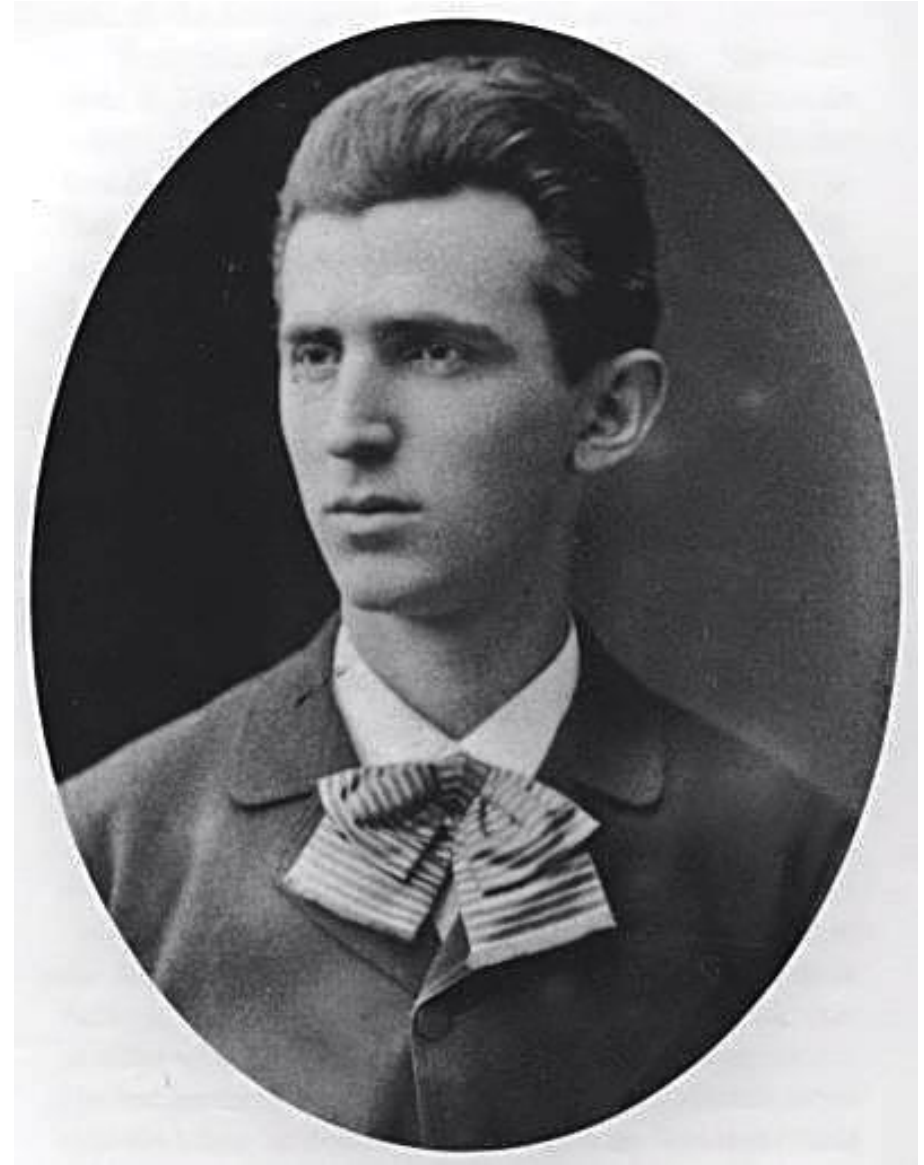
Tesla's mother, Georgina "Đuka" Mandić (1822–1892), whose father was also an Eastern Orthodox Church priest, had a talent for making home craft tools and mechanical appliances and the ability to memorize Serbian epic poems. Đuka had never received a formal education. Tesla credited his eidetic memory and creative abilities to his mother's genetics and influence. Tesla was the fourth of five children. He had three sisters, Milka, Angelina, and Marica, and an older brother named Dane, who was killed in a horse-riding accident when Tesla was aged six or seven.

In 1861, Tesla attended primary school in Smiljan where he studied German, arithmetic, and religion. In 1862, the Tesla family moved to the nearby town of Gospić, where Tesla's father worked as parish priest. Nikola completed primary school, followed by middle school. In 1870, Tesla moved to Karlovac to attend high school at the Higher Real Gymnasium where the classes were held in German, as it was usual throughout schools within the Austro-Hungarian Military Frontier. Later in his patent applications, before he obtained American citizenship, Tesla would identify himself as 'of Smiljan, Lika, border country of Austria-Hungary'.

Tesla later wrote that he became interested in demonstrations of electricity by his physics professor. Tesla noted that these demonstrations of this "mysterious phenomena" made him want "to know more of this wonderful force". Tesla was able to perform integral calculus in his head, which prompted his teachers to believe that he was cheating. He finished a four-year term in three years, graduating in 1873.

After graduating Tesla returned to Smiljan but soon contracted cholera, was bedridden for nine months and was near death multiple times. In a moment of despair, Tesla's father (who had originally wanted him to enter the priesthood), promised to send him to the best engineering school if he recovered from the illness. Tesla later said that he had read Mark Twain's earlier works while recovering from his illness. The next year Tesla evaded conscription into the Austro-Hungarian Army in Smiljan by running away southeast of Lika to Tomingaj, near Gračac. There he explored the mountains wearing hunter's garb. Tesla said that this contact with nature made him stronger, both physically and mentally. He enrolled at the Imperial-Royal Technical College in Graz in 1875 on a Military Frontier scholarship.

Tesla passed nine exams (nearly twice as many as required and received a letter of commendation from the dean of the technical faculty to his father, which stated, "Your son is a star of first rank. At Graz, Tesla noted his fascination with the detailed lectures on electricity presented by Professor Jakob Pöschl and described how he made suggestions on improving the design of an electric motor the professor was demonstrating. But by his third year he was failing in school and never graduated, leaving Graz in December 1878. One biographer suggests Tesla was not studying and may have been expelled for gambling and womanizing. Tesla's family did not hear from him after he left school. There was a rumor among his classmates that he had drowned in the nearby river Mur but in January one of them ran into Tesla in the town of Maribor and reported that encounter to Tesla's family. It turned out Tesla had been working there as a draftsman for 60 florins per month. In March 1879, Milutin finally located his son and tried to convince him to return home and take up his education in Prague.



Tesla returned to Gospić later that month when he was deported for not having a residence permit. Tesla's father died the next month, on 17 April 1879, at the age of 60 after an unspecified illness. During the rest of the year Tesla taught a large class of students in his old school in Gospić.

In January 1880, two of Tesla's uncles put together enough money to help him leave Gospić for Prague, where he was to study. He arrived too late to enroll at Charles-Ferdinand University; he had never studied Greek, a required subject; and he was illiterate in Czech, another required subject. Tesla did, however, attend lectures in philosophy at the university as an auditor but he did not receive grades for the courses.

Working at Budapest Telephone Exchange

Tesla moved to Budapest, Hungary, in 1881 to work under Tivadar Puskás at a telegraph company, the Budapest Telephone Exchange. Upon arrival, Tesla realized that the company, then under construction, was not functional, so he worked as a draftsman in the Central Telegraph Office instead. Within a few months, the Budapest Telephone Exchange became functional, and Tesla was allocated the chief electrician position. During his employment, Tesla made many improvements to the Central Station equipment and claimed to have perfected a telephone repeater or amplifier, which was never patented nor publicly described.

Working at Edison

In 1882, Tivadar Puskás got Tesla another job in Paris with the Continental Edison Company. Tesla began working in what was then a brand new industry, installing indoor incandescent lighting citywide in large scale electric power utility.

The company had several subdivisions and Tesla worked at the Société Electrique Edison, the division in the Ivry-sur-Seine suburb of Paris in charge of installing the lighting system. There he gained a great deal of practical experience in electrical engineering. Management took notice of his advanced knowledge in engineering and physics and soon had him designing and building improved versions of generating dynamos and motors. They also sent him on to troubleshoot engineering problems at other Edison utilities being built around France and in Germany.

Moving to the United States

In 1884, Edison manager Charles Batchelor, who had been overseeing the Paris installation, was brought back to the United States to manage the Edison Machine Works, a manufacturing division situated in New York City, and asked that Tesla be brought to the United States as well. In June 1884, Tesla emigrated and began working almost immediately at the Machine Works on Manhattan's Lower East Side, an overcrowded shop with a workforce of several hundred machinists, laborers, managing staff, and 20 "field engineers" struggling with the task of building the large electric utility in that city.

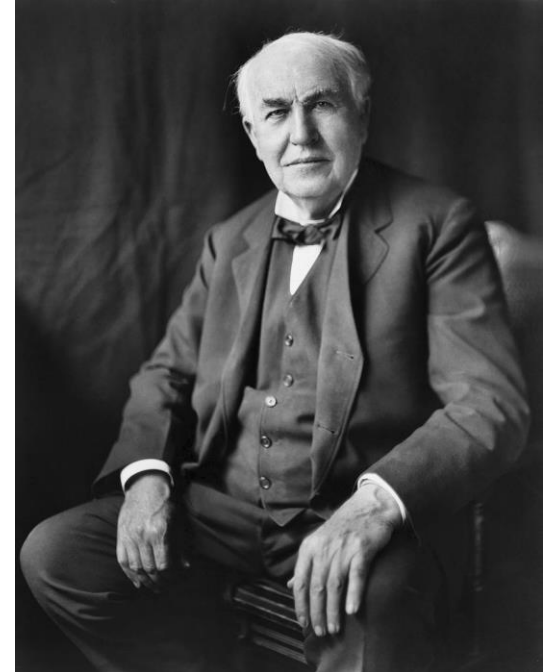
Edison Machine Works on Goerck Street, New York. Tesla found the change from cosmopolitan Europe to working at this shop, located among the tenements on Manhattan's lower east side, a "painful surprise"



As in Paris, Tesla was working on troubleshooting installations and improving generators. Historian W. Bernard Carlson notes Tesla may have met company founder Thomas Edison only a couple of times. One of those times was noted in Tesla's autobiography where, after staying up all night repairing the damaged dynamos on the ocean liner SS Oregon, he ran into Batchelor and Edison, who made a quip about their "Parisian" being out all night. After Tesla told them he had been up all night fixing the Oregon, Edison commented to Batchelor that "this is a damned good man". One of the projects given to Tesla was to develop an arc lamp-based street lighting system. Arc lighting was the most popular type of street lighting but it required high voltages and was incompatible with the Edison low-voltage incandescent system, causing the company to lose contracts in some cities. Tesla's designs were never put into production, possibly because of technical improvements in incandescent street lighting or because of an installation deal that Edison made with an arc lighting company.

Tesla had been working at the Machine Works for a total of six months when he quit. What event precipitated his leaving is unclear. It may have been over a bonus he did not receive, either for redesigning generators or for the arc lighting system that was shelved. Tesla had previous run-ins with the Edison company over unpaid bonuses he believed he had earned.

Thomas Alva Edison (February 11, 1847 – October 18, 1931) was an American inventor and businessman. He developed many devices in fields such as electric power generation, mass communication, sound recording, and motion pictures. These inventions, which include the phonograph, the motion picture camera, and early versions of the electric light bulb,



In his autobiography, Tesla stated the manager of the Edison Machine Works offered a \$50,000 bonus to design "twenty-four different types of standard machines" "but it turned out to be a practical joke". Later versions of this story have Thomas Edison himself offering and then reneging on the deal, quipping "Tesla, you don't understand our American humor". The size of the bonus in either story has been noted as odd since Machine Works manager Batchelor was stingy with pay and the company did not have that amount of cash (equal to \$1,695,556 today) on hand. Tesla's diary contains just one comment on what happened at the end of his employment, a note he scrawled across the two pages covering 7 December 1884, to 4 January 1885, saying "Good By to the Edison Machine Works".

Tesla Electric Light and Manufacturing

Soon after leaving the Edison company, Tesla was working on patenting an arc lighting system, possibly the same one he had developed at Edison. In March 1885, he met with patent attorney Lemuel W. Serrell, the same attorney used by Edison, to obtain help with submitting the patents. Serrell introduced Tesla to two businessmen, Robert Lane and Benjamin Vail, who agreed to finance an arc lighting manufacturing and utility company in Tesla's name, the Tesla Electric Light and Manufacturing Company. Tesla worked for the rest of the year obtaining the patents that included an improved DC generator, the first patents issued to Tesla in the US, and building and installing the system in Rahway, New Jersey. Tesla's new system gained notice in the technical press, which commented on its advanced features.

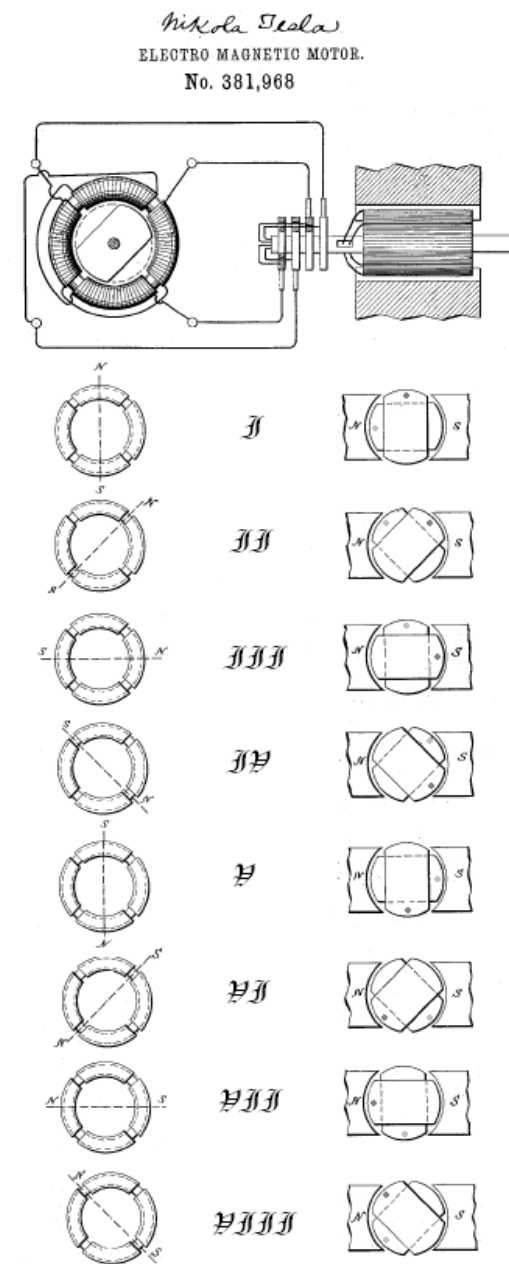
The investors showed little interest in Tesla's ideas for new types of alternating current motors and electrical transmission equipment. After the utility was up and running in 1886, they decided that the manufacturing side of the business was too competitive and opted to simply run an electric utility. They formed a new utility company, abandoning Tesla's company and leaving the inventor penniless. Tesla even lost control of the patents he had generated, since he had assigned them to the company in exchange for stock. He had to work at various electrical repair jobs and as a ditch digger for \$2 per day. Later in life Tesla recounted that part of 1886 as a time of hardship, writing "My high education in various branches of science, mechanics and literature seemed to me like a mockery".

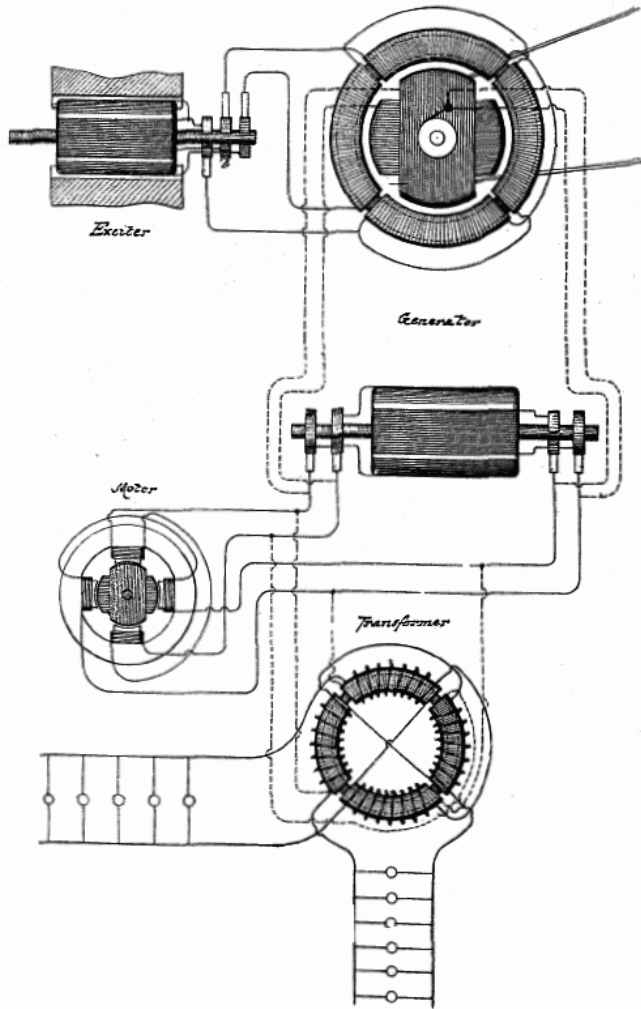
AC and the induction motor

In late 1886, Tesla met Alfred S. Brown, a Western Union superintendent, and New York attorney Charles Fletcher Peck. The two men were experienced in setting up companies and promoting inventions and patents for financial gain. Based on Tesla's new ideas for electrical equipment, including a thermo-magnetic motor idea,[66] they agreed to back the inventor financially and handle his patents. Together they formed the Tesla Electric Company in April 1887, with an agreement that profits from generated patents would go 1/3 to Tesla, 1/3 to Peck and Brown, and 1/3 to fund development. They set up a laboratory for Tesla at 89 Liberty Street in Manhattan, where he worked on improving and developing new types of electric motors, generators, and other devices.

In 1887, Tesla developed an induction motor that ran on alternating current (AC), a power system format that was rapidly expanding in Europe and the United States because of its advantages in long-distance, high-voltage transmission. The motor used polyphase current, which generated a rotating magnetic field to turn the motor (a principle that Tesla claimed to have conceived in 1882). This innovative electric motor, patented in May 1888, was a simple self-starting design that did not need a commutator, thus avoiding sparking and the high maintenance of constantly servicing and replacing mechanical brushes.

Along with getting the motor patented, Peck and Brown arranged to get the motor publicized, starting with independent testing to verify it was a functional improvement, followed by press releases sent to technical publications for articles to run concurrently with the issue of the patent. Physicist William Arnold Anthony (who tested the motor) and Electrical World magazine editor Thomas Commerford Martin arranged for Tesla to demonstrate his AC motor on 16 May 1888 at the American Institute of Electrical Engineers. Engineers working for the Westinghouse Electric & Manufacturing Company reported to George Westinghouse that Tesla had a viable AC motor and related power system—something Westinghouse needed for the alternating current system he was already marketing.





Tesla's AC dynamo-electric machine (AC electric generator) in an 1888 U.S. patent 390,721



Photograph of George Westinghouse Jr. (October 6, 1846 – March 12, 1914) in 1884 - American entrepreneur and engineer based in Pennsylvania

Westinghouse looked into getting a patent on a similar commutator-less, rotating magnetic field-based induction motor developed in 1885 and presented in a paper in March 1888 by Italian physicist Galileo Ferraris, but decided that Tesla's patent would probably control the market. In July 1888, Brown and Peck negotiated a licensing deal with George Westinghouse for Tesla's polyphase induction motor and transformer designs for \$60,000 in cash and stock and a royalty of \$2.50 per AC horsepower produced by each motor. Westinghouse also hired Tesla for one year for the large fee of \$2,000 (\$67,800 in today's dollars) per month to be a consultant at the Westinghouse Electric & Manufacturing Company's Pittsburgh labs. During that year, Tesla worked in Pittsburgh, helping to create an alternating current system to power the city's streetcars. He found it a frustrating period because of conflicts with the other Westinghouse engineers over how best to implement AC power.

Market turmoil

Tesla's demonstration of his induction motor and Westinghouse's subsequent licensing of the patent, both in 1888, came at the time of extreme competition between electric companies. The three big firms, Westinghouse, Edison, and Thomson-Houston Electric Company, were trying to grow in a capital-intensive business while financially undercutting each other. There was even a "war of currents" propaganda campaign going on, with Edison Electric claiming their direct current system was better and safer than the Westinghouse alternating current system and Thomson-Houston sometimes siding with Edison. Competing in this market meant Westinghouse would not have the cash or engineering resources to develop Tesla's motor and the related polyphase system right away.

Two years after signing the Tesla contract, Westinghouse Electric was in trouble. The near collapse of Barings Bank in London triggered the financial panic of 1890, causing investors to call in their loans to Westinghouse Electric. The sudden cash shortage forced the company to refinance its debts. The new lenders demanded that Westinghouse cut back on what looked like excessive spending on acquisition of other companies, research, and patents, including the per motor royalty in the Tesla contract. At that point, the Tesla induction motor had been unsuccessful and was stuck in development. Westinghouse was paying a \$15,000-a-year guaranteed royalty even though operating examples of the motor were rare and polyphase power systems needed to run it were even rarer. In early 1891, George Westinghouse explained his financial difficulties to Tesla in stark terms, saying that, if he did not meet the demands of his lenders, he would no longer be in control of Westinghouse Electric and Tesla would have to "deal with the bankers" to try to collect future royalties.

The advantages of having Westinghouse continue to champion the motor probably seemed obvious to Tesla and he agreed to release the company from the royalty payment clause in the contract. Six years later Westinghouse purchased Tesla's patent for a lump sum payment of \$216,000 as part of a patent-sharing agreement signed with General Electric (a company created from the 1892 merger of Edison and Thomson-Houston)

New York laboratories

The money Tesla made from licensing his AC patents made him independently wealthy and gave him the time and funds to pursue his own interests. In 1889, Tesla moved out of the Liberty Street shop Peck and Brown had rented and for the next dozen years worked out of a series of workshop/laboratory spaces in Manhattan. These included a lab at 175 Grand Street (1889–1892), the fourth floor of 33–35 South Fifth Avenue (1892–1895), and sixth and seventh floors of 46 & 48 East Houston Street (1895–1902). Tesla and his hired staff conducted some of his most significant work in these workshops.



General Electric Company (GE) was an American multinational conglomerate founded in 1892, incorporated in the state of New York and headquartered in Boston. The company had several divisions, including aerospace, energy, healthcare, and finance.

In the summer of 1889, Tesla traveled to the 1889 Exposition Universelle in Paris and learned of Heinrich Hertz's 1886–1888 experiments that proved the existence of electromagnetic radiation, including radio waves. In repeating and then expanding on these experiments Tesla tried powering a Ruhmkorff coil with a high speed alternator he had been developing as part of an improved arc lighting system but found that the high-frequency current overheated the iron core and melted the insulation between the primary and secondary windings in the coil. To fix this problem Tesla came up with his "oscillating transformer", with an air gap instead of insulating material between the primary and secondary windings and an iron core that could be moved to different positions in or out of the coil.

Later called the Tesla coil, it would be used to produce high-voltage, low-current, high frequency alternating-current electricity. He would use this resonant transformer circuit in his later wireless power work. On 30 July 1891, aged 35, Tesla became a naturalized citizen of the United States. In the same year, he patented his Tesla coil.

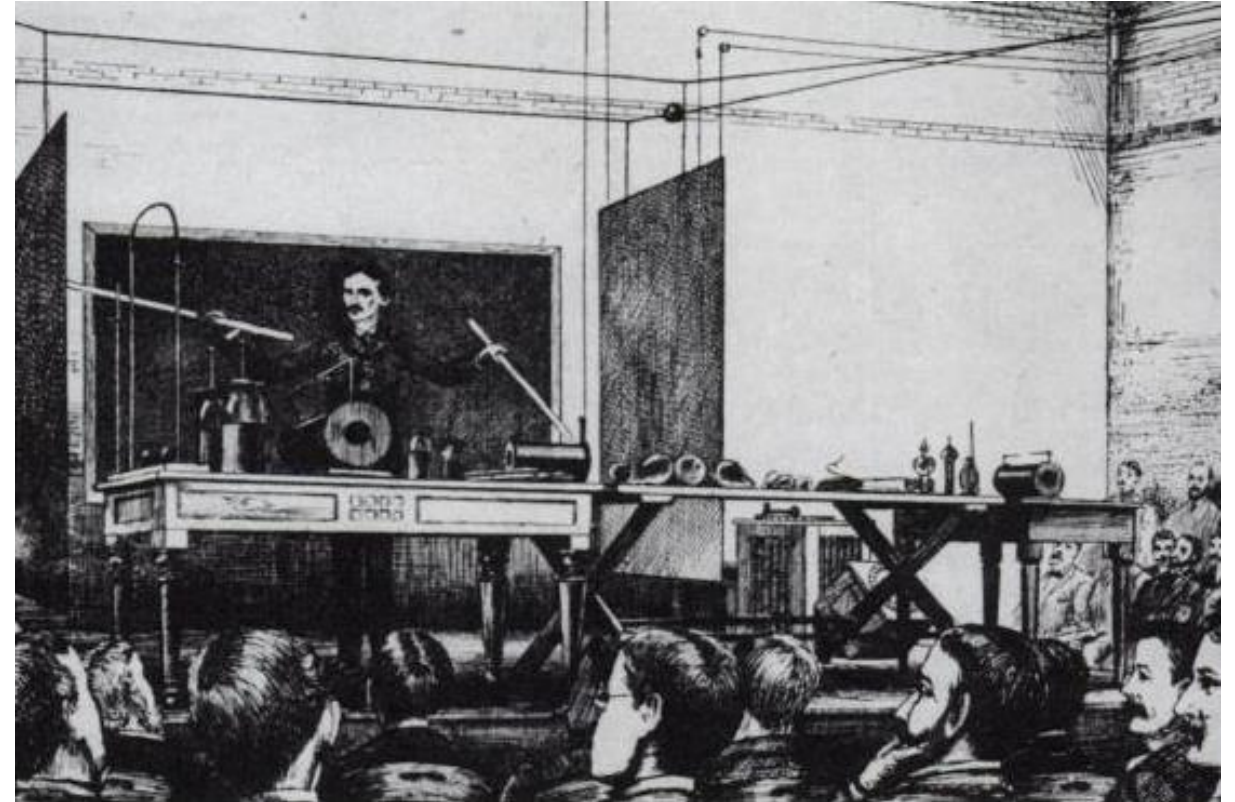
A Tesla coil is an electrical resonant transformer circuit designed by inventor Nikola Tesla in 1891. It is used to produce high-voltage, low-current, high-frequency alternating-current electricity. Tesla experimented with a number of different configurations consisting of two, or sometimes three, coupled resonant electric circuits.



Wireless lighting

After 1890, Tesla experimented with transmitting power by inductive and capacitive coupling using high AC voltages generated with his Tesla coil. He attempted to develop a wireless lighting system based on near-field inductive and capacitive coupling and conducted a series of public demonstrations where he lit Geissler tubes and even incandescent light bulbs from across a stage. He spent most of the decade working on variations of this new form of lighting with the help of various investors but none of the ventures succeeded in making a commercial product out of his findings.

In 1893 at St. Louis, Missouri, the Franklin Institute in Philadelphia, Pennsylvania and the National Electric Light Association, Tesla told onlookers that he was sure a system like his could eventually conduct "intelligible signals or perhaps even power to any distance without the use of wires" by conducting it through the Earth.



Tesla demonstrating wireless lighting by "electrostatic induction" during an 1891 lecture at Columbia College via two long Geissler tubes (similar to neon tubes) in his hands



Polyphase system and the Columbian Exposition

By the beginning of 1893, Westinghouse engineer Charles F. Scott and then Benjamin G. Lamme had made progress on an efficient version of Tesla's induction motor. Lamme found a way to make the polyphase system it would need compatible with older single-phase AC and DC systems by developing a rotary converter. Westinghouse Electric now had a way to provide electricity to all potential customers and started branding their polyphase AC system as the "Tesla Polyphase System". They believed that Tesla's patents gave them patent priority over other polyphase AC systems. Westinghouse Electric asked Tesla to participate in the 1893 World's Columbian Exposition in Chicago where the company had a large space in the "Electricity Building" devoted to electrical exhibits. Westinghouse Electric won the bid to light the Exposition with alternating current and it was a key event in the history of AC power, as the company demonstrated to the American public the safety, reliability, and efficiency of an alternating current system that was polyphase and could also supply the other AC and DC exhibits at the fair.



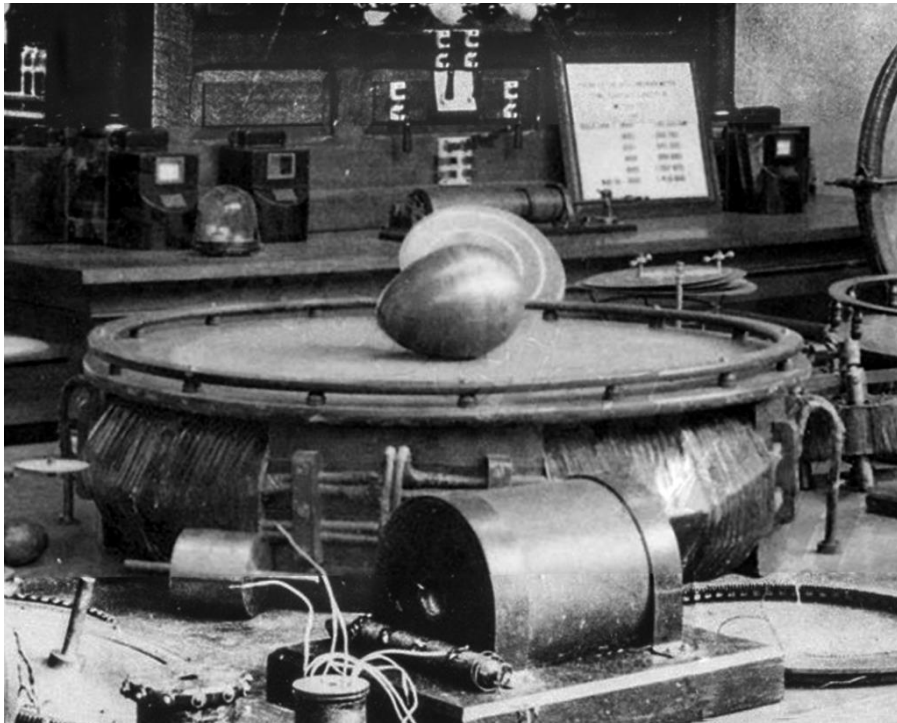
A Westinghouse display of the "Tesla Polyphase System" at Chicago's 1893 Columbian Exposition



The World's Columbian Exposition, also known as the Chicago World's Fair, was a world's fair held in Chicago from May 5 to October 31, 1893, to celebrate the 400th anniversary of Christopher Columbus's arrival in the New World in 1492. The centerpiece of the Fair, held in Jackson Park, was a large water pool representing the voyage that Columbus took to the New World. Chicago won the right to host the fair over several competing cities, including New York City, Washington, D.C., and St. Louis.

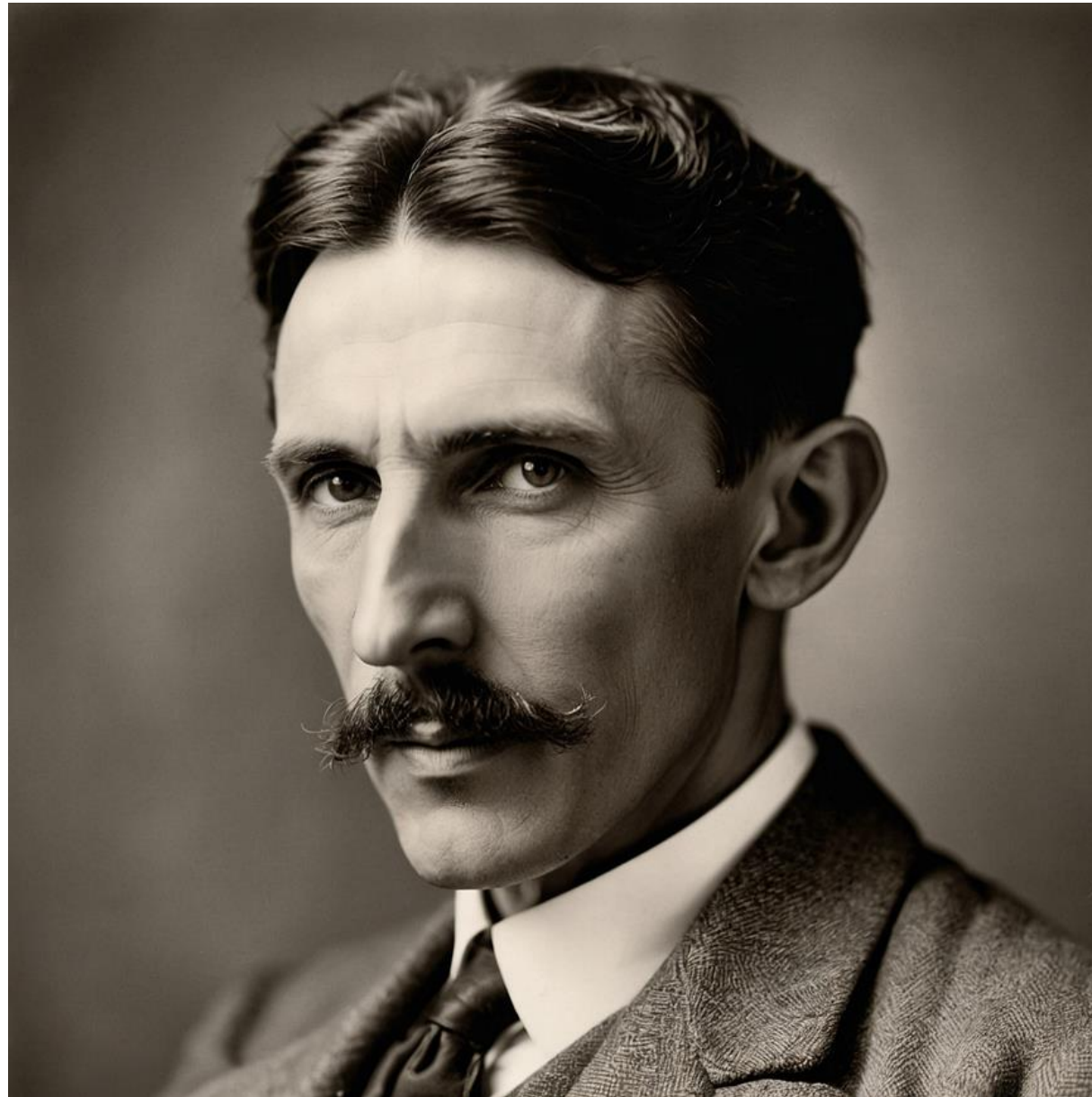
A special exhibit space was set up to display various forms and models of Tesla's induction motor. The rotating magnetic field that drove them was explained through a series of demonstrations including an Egg of Columbus that used the two-phase coil found in an induction motor to spin a copper egg making it stand on end.

Tesla visited the fair for a week during its six-month run to attend the International Electrical Congress and put on a series of demonstrations at the Westinghouse exhibit. A specially darkened room had been set up where Tesla showed his wireless lighting system, using a demonstration he had previously performed throughout America and Europe; these included using high-voltage, high-frequency alternating current to light wireless gas-discharge lamps.



Tesla's Egg of Columbus was a device exhibited in the Westinghouse Electric display at the 1893 Chicago World's Columbian Exposition to explain the rotating magnetic field that drove the new alternating current induction motors designed by inventor Nikola Tesla by using that magnetic field to spin a copper egg on end.





Gas-discharge lamps are a family of artificial light sources that generate light by sending an electric discharge through an ionized gas, a plasma.

Typically, such lamps use a noble gas (**argon, neon, krypton, and xenon**) or a mixture of these gases.



Steam-powered oscillating generator

During his presentation at the International Electrical Congress in the Columbian Exposition Agriculture Hall, Tesla introduced his steam powered reciprocating electricity generator that he patented that year, something he thought was a better way to generate alternating current. Steam was forced into the oscillator and rushed out through a series of ports, pushing a piston up and down that was attached to an armature.



TESLA'S OSCILLATOR AS SHOWN AT THE COLUMBIAN EXPOSITION.

Tesla's electro-mechanical oscillator is a steam-powered electric generator patented by Nikola Tesla in 1893. Later in life, Tesla claimed one version of the oscillator caused an earthquake in New York City in 1898, gaining it the colloquial title "Tesla's earthquake machine".

The magnetic armature vibrated up and down at high speed, producing an alternating magnetic field. This induced alternating electric current in the wire coils located adjacent. It did away with the complicated parts of a steam engine/generator, but never caught on as a feasible engineering solution to generate electricity.

Consulting on Niagara

In 1893, Edward Dean Adams, who headed the Niagara Falls Cataract Construction Company, sought Tesla's opinion on what system would be best to transmit power generated at the falls. Over several years, there had been a series of proposals and open competitions on how best to do it. Among the systems proposed by several US and European companies were two-phase and three-phase AC, high-voltage DC, and compressed air. Adams asked Tesla for information about the current state of all the competing systems. Tesla advised Adams that a two-phased system would be the most reliable and that there was a Westinghouse system to light incandescent bulbs using two-phase alternating current. The company awarded a contract to Westinghouse Electric for building a two-phase AC generating system at the Niagara Falls, based on Tesla's advice and Westinghouse's demonstration at the Columbian Exposition. At the same time, a further contract was awarded to General Electric to build the AC distribution system.

Schoellkopf Stations 3, 3-B and 3-C



In 1860, Horace H. Day purchased the company and renamed it the "Niagara Falls Canal Company." At an investment of \$1.5 million, (equivalent to \$42,919,000 in 2023) the canal was finally completed in 1861,

The Nikola Tesla Company

In 1895, Edward Dean Adams, impressed with what he saw when he toured Tesla's lab, agreed to help found the Nikola Tesla Company, set up to fund, develop, and market a variety of previous Tesla patents and inventions as well as new ones. Alfred Brown signed on, bringing along patents developed under Peck and Brown. The board was filled out with William Birch Rankine and Charles F. Coaney. It found few investors since the mid-1890s were a tough time financially, and the wireless lighting and oscillators patents it was set up to market never panned out. The company handled Tesla's patents for decades to come.



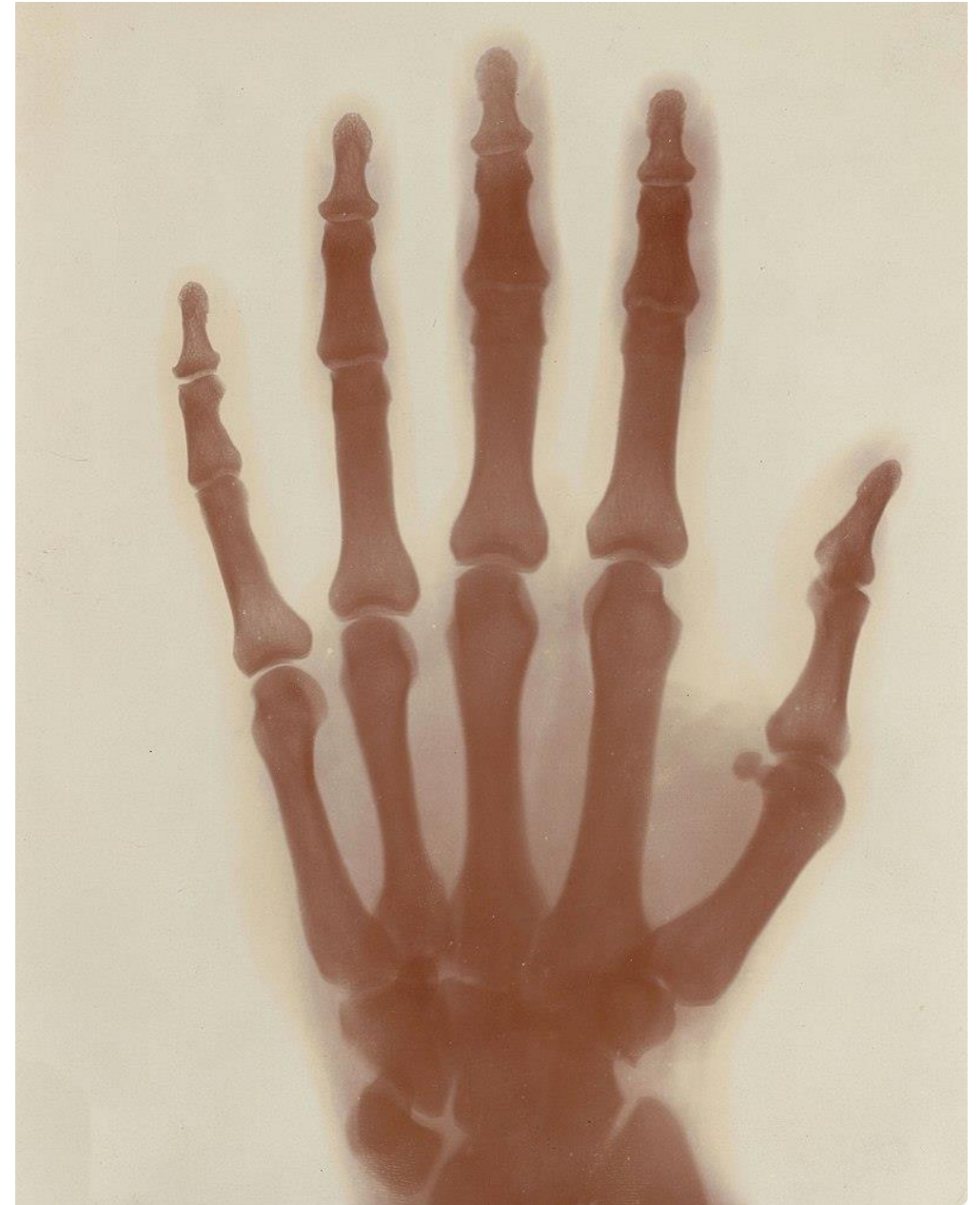
Lab fire

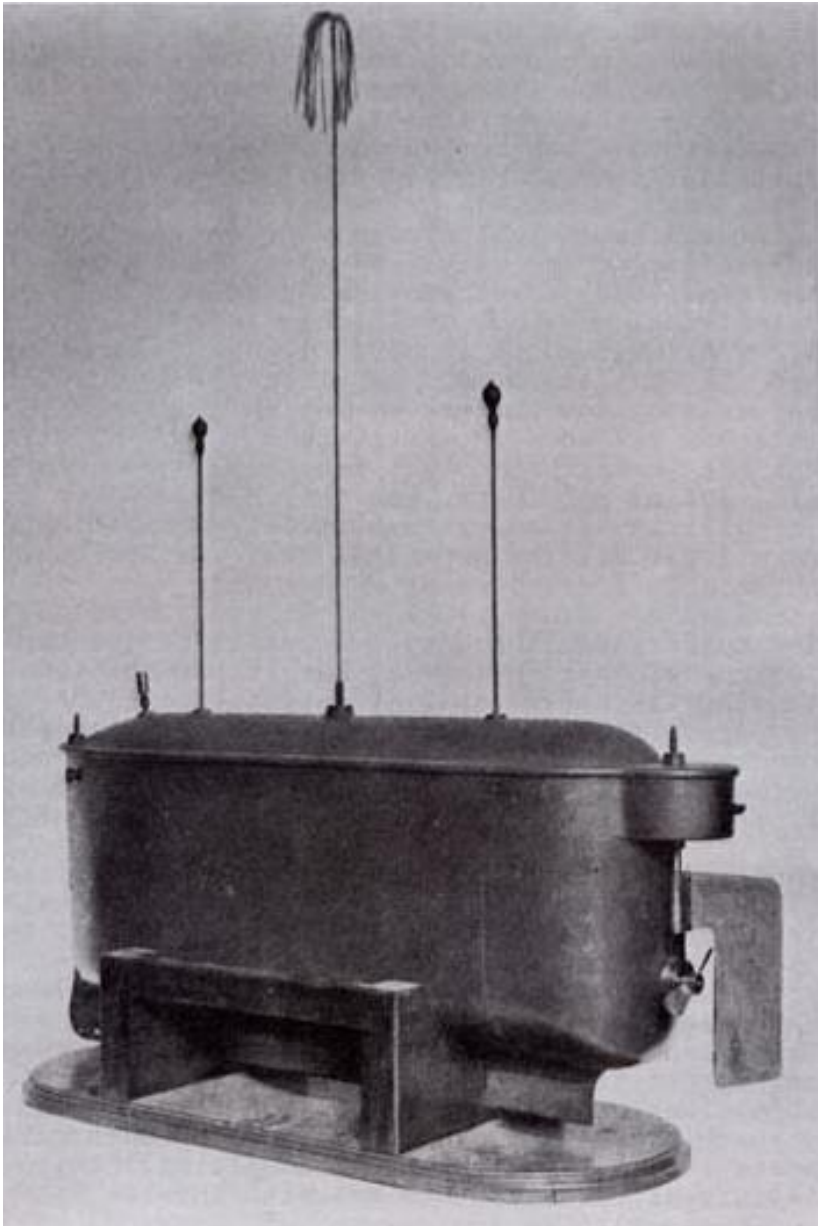
In the early morning hours of 13 March 1895, the South Fifth Avenue building that housed Tesla's lab caught fire. It started in the basement of the building and was so intense Tesla's 4th-floor lab burned and collapsed into the second floor. The fire not only set back Tesla's ongoing projects, but it also destroyed a collection of early notes and research material, models, and demonstration pieces, including many that had been exhibited at the 1893 Worlds Colombian Exposition. Tesla told The New York Times "I am in too much grief to talk. What can I say?". After the fire Tesla moved to 46 & 48 East Houston Street and rebuilt his lab on the 6th and 7th floors.



X-ray experimentation

Starting in 1894, Tesla began investigating what he referred to as radiant energy of "invisible" kinds after he had noticed damaged film in his laboratory in previous experiments (later identified as "Roentgen rays" or "X-rays"). His early experiments were with Crookes tubes, a cold cathode electrical discharge tube. Tesla may have inadvertently captured an X-ray image—predating, by a few weeks, Wilhelm Röntgen's December 1895 announcement of the discovery of X-rays—when he tried to photograph Mark Twain illuminated by a Geissler tube, an earlier type of gas discharge tube. The only thing captured in the image was the metal locking screw on the camera lens.





In 1898, Tesla demonstrated a radio-controlled boat, which he hoped to sell as a guided torpedo to navies around the world.

In 1898, Tesla demonstrated a boat that used a coherer-based radio control—which he dubbed "telautomaton"—to the public during an electrical exhibition at Madison Square Garden. Tesla tried to sell his idea to the US military as a type of radio-controlled torpedo, but they showed little interest. Remote radio control remained a novelty until World War I and afterward, when a number of countries used it in military programs. Tesla took the opportunity to further demonstrate "Teleautomatics" in an address to a meeting of the Commercial Club in Chicago, while he was traveling to Colorado Springs, on 13 May 1899.





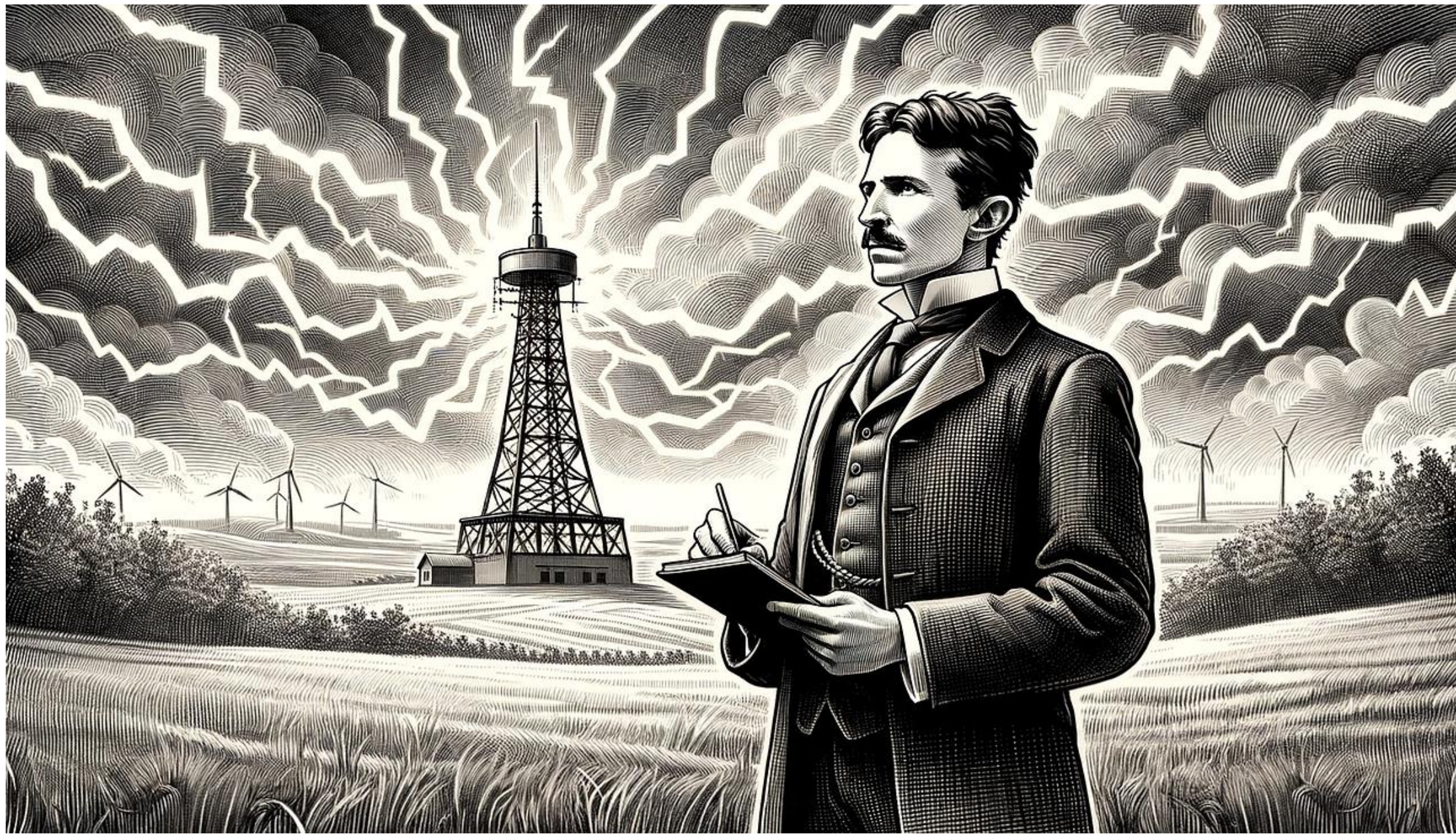
Wireless power

Tesla went on to develop a wireless power distribution system that he hoped would be capable of transmitting power long distance directly into homes and factories. Early on he seemed to borrow from the ideas of Mahlon Loomis, proposing a system composed of balloons to suspend transmitting and receiving electrodes in the air above 30,000 feet (9,100 m) in altitude, where he thought the pressure would allow him to send high voltages (millions of volts) long distances. To further study the conductive nature of low pressure air he set up a test facility at high altitude in Colorado Springs during 1899. Experiments he conducted there with a large coil operating in the megavolts range, as well as observations he made of the electronic noise of lightning strikes, led him to conclude incorrectly that he could use the entire globe of the Earth to conduct electrical energy. The theory included driving alternating current pulses into the Earth at its resonant frequency from a grounded Tesla coil working against an elevated capacitance to make the potential of the Earth oscillate. Tesla thought this would allow alternating current to be received with a similar capacitive antenna tuned to resonance with it at any point on Earth with very little power loss.



Experiment in resonant inductive transfer by Tesla at Colorado Springs 1899. The coil is in resonance with Tesla's magnifying transmitter nearby, powering the light bulb at bottom. (right) Tesla's unsuccessful Wardenclyffe power station.

After 1890, inventor Nikola Tesla experimented with transmitting power by inductive and capacitive coupling using spark-excited radio frequency resonant transformers, now called Tesla coils, which generated high AC voltages. Early on he attempted to develop a wireless lighting system based on near-field inductive and capacitive coupling and conducted a series of public demonstrations where he lit Geissler tubes and even incandescent light bulbs from across a stage. He found he could increase the distance at which he could light a lamp by using a receiving LC circuit tuned to resonance with the transmitter's LC circuit. using resonant inductive coupling. Tesla failed to make a commercial product out of his findings but his resonant inductive coupling method is now widely used in electronics and is currently being applied to short-range wireless power systems.

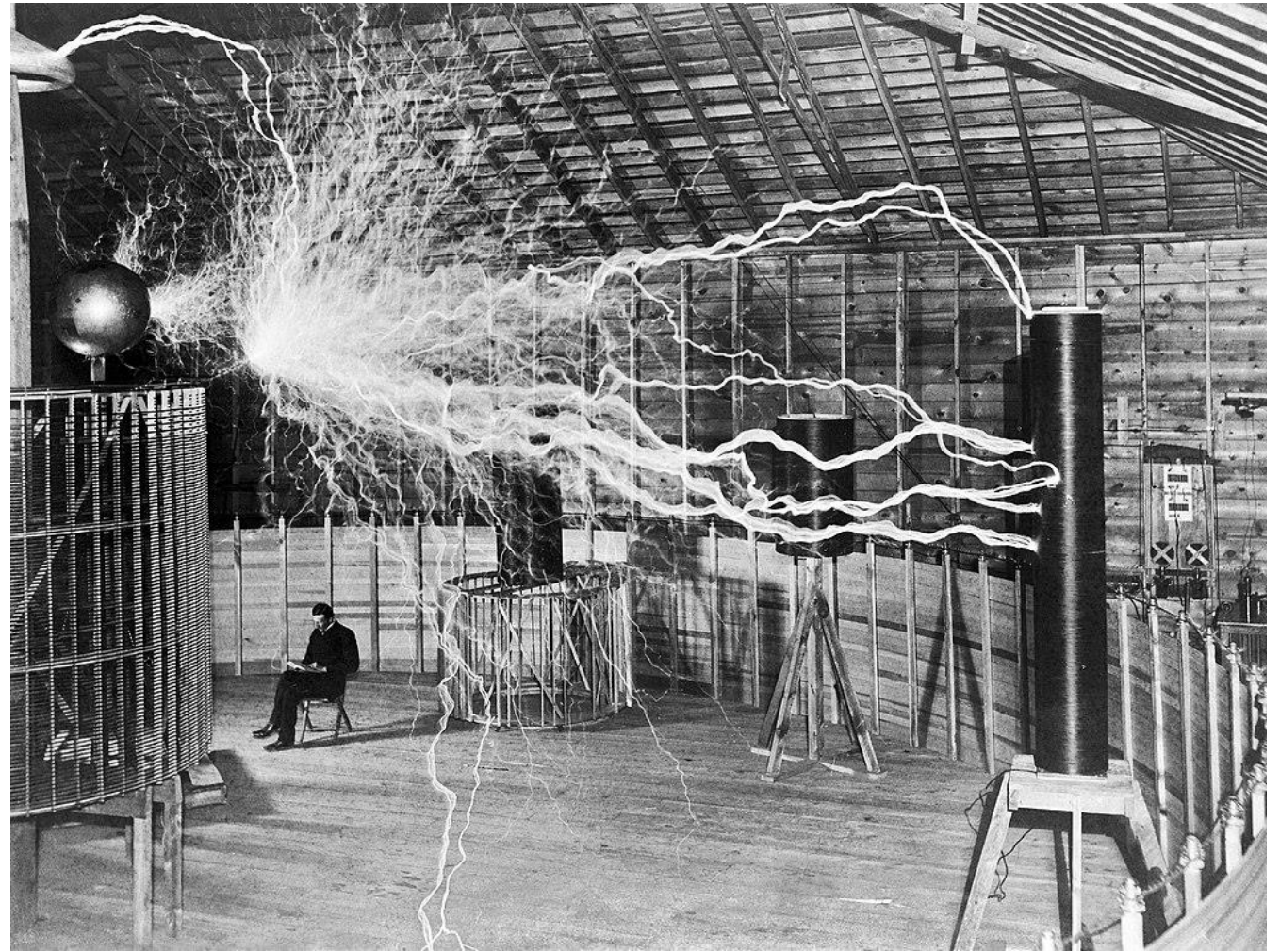
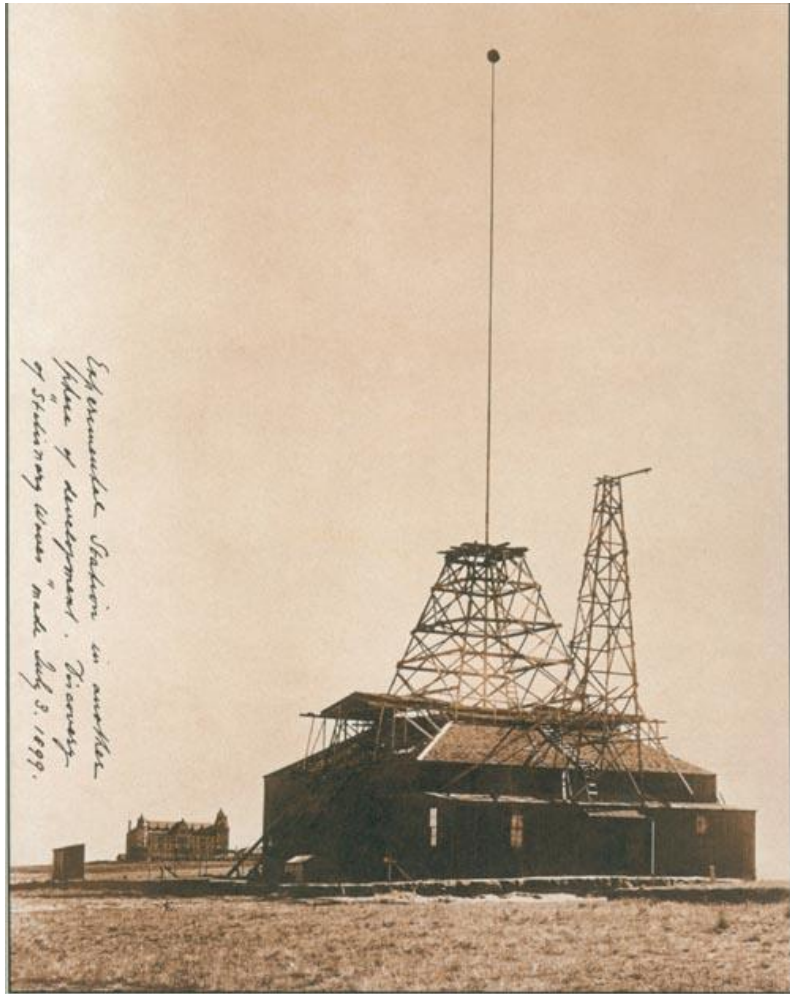


His observations also led him to believe a high voltage used in a coil at an elevation of a few hundred feet would "break the air stratum down", eliminating the need for miles of cable hanging on balloons to create his atmospheric return circuit. Tesla would go on the next year to propose a "World Wireless System" that was to broadcast both information and power worldwide. In 1901, at Shoreham, New York he attempted to construct a large high-voltage wireless power station, now called Wardenclyffe Tower, but by 1904 investment dried up and the facility was never completed.

Post-war developments

Before World War II, little progress was made in wireless power transmission. Radio was developed for communication uses, but could not be used for power transmission since the relatively low-frequency radio waves spread out in all directions and little energy reached the receiver. In radio communication, at the receiver, an amplifier intensifies a weak signal using energy from another source. For power transmission, efficient transmission required transmitters that could generate higher-frequency microwaves, which can be focused in narrow beams towards a receiver.

The development of microwave technology during World War II, such as the klystron and magnetron tubes and parabolic antennas, made radiative (far-field) methods practical for the first time, and the first long-distance wireless power transmission was achieved in the 1960s by William C. Brown. In 1964, Brown invented the rectenna which could efficiently convert microwaves to DC power, and in 1964 demonstrated it with the first wireless-powered aircraft, a model helicopter powered by microwaves beamed from the ground.



A multiple exposure picture (one of 68 images created by Century Magazine photographer Dickenson Alley) of Tesla sitting in his Colorado Springs laboratory with his "magnifying transmitter" generating millions of volts. The 7-metre (23 ft) long arcs were not part of the normal operation, but only produced for effect by rapidly cycling the power switch.

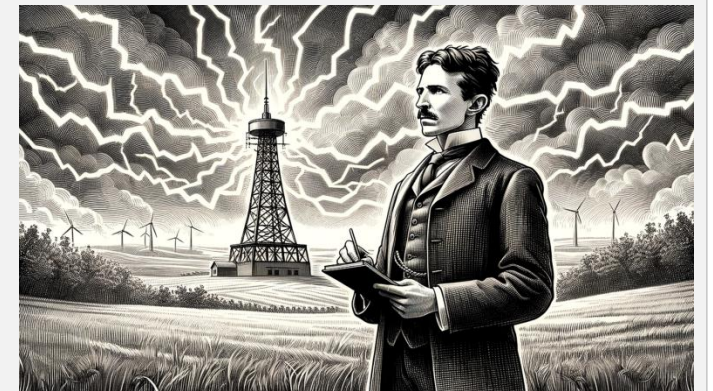
The Tesla Experimental Station was a laboratory in Colorado Springs, Colorado, USA built in 1899 by inventor Nikola Tesla and for his study of the use of high-voltage, high-frequency electricity in wireless power transmission. Tesla used it for only one year, until 1900, and it was torn down in 1904 to pay his outstanding debts.

In May 1899, Tesla, several of his assistants, and a local contractor commenced the construction of Tesla's laboratory shortly after arriving in Colorado Springs, a high-altitude location where he would have more room than in his downtown New York City laboratory for his high-voltage, high-frequency experiments. Tesla moved there to study the conductive nature of low pressure air, part of his research into wireless transmission of electrical power. The lab possessed the largest Tesla coil ever built, 49.25 feet (15.01 m) in diameter, which was a preliminary version of the magnifying transmitter planned for installation in the Wardenclyffe Tower. Upon his arrival, he told reporters that he planned to conduct wireless telegraphy experiments, transmitting signals from Pikes Peak to Paris.

He produced artificial lightning, with discharges consisting of millions of volts and up to 135 feet (41 m) long. People walking along the street observed sparks jumping between their feet and the ground. Sparks sprang from water line taps when touched. Light bulbs within 100 feet (30 m) of the lab glowed even when turned off. Horses in a livery stable bolted from their stalls after receiving shocks through their metal shoes. Butterflies were electrified, swirling in circles with blue halos of St. Elmo's fire around their wings.



An Alley photograph from Colorado Springs documenting three lights receiving power by means of electrodynamic induction from an oscillator 60 feet (18 m) from the bulbs (placed on the ground outside the building to demonstrate they had no connection to the power source).

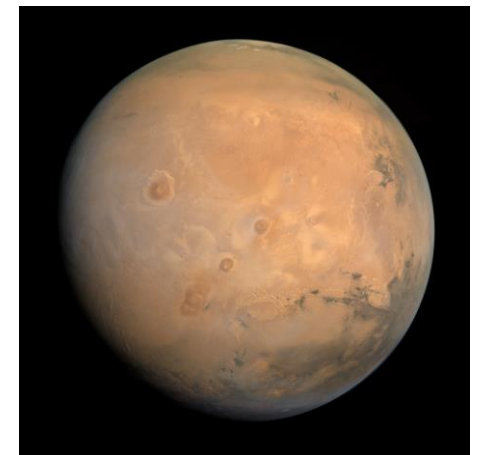




While experimenting, Tesla inadvertently faulted a power station generator, causing a power outage. In August 1917, Tesla explained what had happened in The Electrical Experimenter: "As an example of what has been done with several hundred kilowatts of high frequency energy liberated, it was found that the dynamos in a power house 6 miles (10 km) away were repeatedly burned out, due to the powerful high frequency currents set up in them, and which caused heavy sparks to jump through the windings and destroy the insulation!"

During his time at his laboratory Tesla observed unusual signals from his receiver which he concluded might be communications from another planet. He mentioned them in a letter to reporter Julian Hawthorne at the Philadelphia North American on 8 December 1899 and in a December 1900 letter about possible discoveries in the new century to the Red Cross Society where he referred to messages "from another world" that read "1 ... 2 ... 3 ...". Reporters treated it as a sensational story and jumped to the conclusion Tesla was hearing signals from Mars.

Mars is the fourth planet from the Sun. The surface of Mars is orange-red because it is covered in iron(III) oxide dust, giving it the nickname "the Red Planet". Mars is among the brightest objects in Earth's sky, and its high-contrast albedo features have made it a common subject for telescope viewing. It is classified as a terrestrial planet and is the second smallest of the Solar System's planets with a diameter of 6,779 km (4,212 mi). In terms of orbital motion, a Martian solar day (sol) is equal to 24.6 hours, and a Martian solar year is equal to 1.88 Earth years (687 Earth days). Mars has two natural satellites that are small and irregular in shape: Phobos and Deimos.



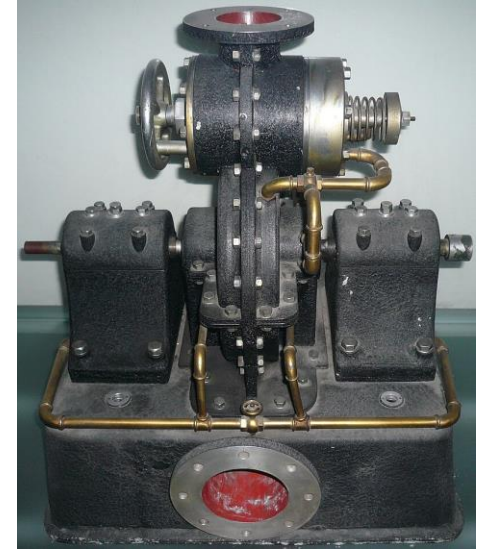
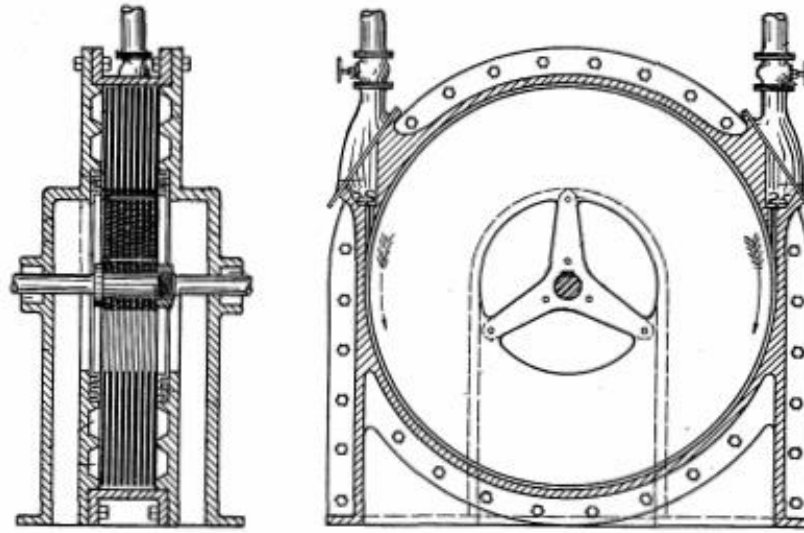
Investors on Wall Street were putting their money into Marconi's system, and some in the press began turning against Tesla's project, claiming it was a hoax. The project came to a halt in 1905, and in 1906, the financial problems and other events may have led to what Tesla biographer Marc J. Seifer suspects was a nervous breakdown on Tesla's part. Tesla mortgaged the Wardenclyffe property to cover his debts at the Waldorf-Astoria, which eventually amounted to \$20,000 (\$608,400 in today's dollars. He lost the property in foreclosure in 1915, and in 1917 the Tower was demolished by the new owner to make the land a more viable real estate asset.



Guglielmo Giovanni Maria Marconi, 1st Marchese of Marconi (25 April 1874 – 20 July 1937) was an Italian electrical engineer, inventor, physicist and politician known for his creation of a practical radio wave-based wireless telegraph system. This led to Marconi being credited as the inventor of radio and sharing the 1909 Nobel Prize in Physics with Karl Ferdinand Braun "in recognition of their contributions to the development of wireless telegraphy". His work laid the foundation for the development of radio, television and all modern wireless communication systems. From youth, Marconi was interested in science and electricity. In the early 1890s, he began working on the idea of "wireless telegraphy"

At the age of 20, Marconi began to conduct experiments in radio waves, building much of his own equipment in the attic of his home at the Villa Griffone in Pontecchio

After Wardenclyffe closed, Tesla continued to write to Morgan; after "the great man" died, Tesla wrote to Morgan's son Jack, trying to get further funding for the project. In 1906, Tesla opened offices at 165 Broadway in Manhattan, trying to raise further funds by developing and marketing his patents. He went on to have offices at the Metropolitan Life Tower from 1910 to 1914; rented for a few months at the Woolworth Building, moving out because he could not afford the rent; and then to office space at 8 West 40th Street from 1915 to 1925. After moving to 8 West 40th Street, he was effectively bankrupt. Most of his patents had run out and he was having trouble with the new inventions he was trying to develop.



The Tesla turbine is a bladeless centripetal flow turbine invented by Nikola Tesla in 1913. It functions as nozzles apply a moving fluid to the edges of a set of discs. The engine uses smooth discs rotating in a chamber to generate rotational movement due to the momentum exchange between the fluid and the discs. The discs are arranged in an orientation similar to a stack of CDs on an axle. The Tesla turbine uses the boundary-layer effect, instead of the method employed by more conventional turbines, wherein a fluid acts on blades. One of Tesla's intended implementations for this turbine was for the generation of geothermal power, which he described in his work *Our Future Motive Power*.

Wireless lawsuits

When World War I broke out, the British cut the transatlantic telegraph cable linking the US to Germany in order to control the flow of information between the two countries. They also tried to shut off German wireless communication to and from the US by having the US Marconi Company sue the German radio company Telefunken for patent infringement. Telefunken brought in the physicists Jonathan Zenneck and Karl Ferdinand Braun for their defense, and hired Tesla as a witness for two years for \$1,000 a month. The case stalled and then went moot when the US entered the war against Germany in 1917.

In 1915, Tesla attempted to sue the Marconi Company for infringement of his wireless tuning patents. Marconi's initial radio patent had been awarded in the US in 1897, but his 1900 patent submission covering improvements to radio transmission had been rejected several times, before it was finally approved in 1904, on the grounds that it infringed on other existing patents including two 1897 Tesla wireless power tuning patents. Tesla's 1915 case went nowhere, but in a related case, where the Marconi Company tried to sue the US government over WWI patent infringements, a Supreme Court of the United States 1943 decision restored the prior patents of Oliver Lodge, John Stone, and Tesla. The court declared that their decision had no bearing on Marconi's claim as the first to achieve radio transmission, just that since Marconi's claim to certain patented improvements were questionable, the company could not claim infringement on those same patents.

Other awards, patents and ideas

Tesla won numerous medals and awards over this time. They include:

Grand Officer of the Order of St. Sava (Serbia, 1892)

Elliott Cresson Medal (Franklin Institute, US, 1894)

Grand Cross of the Order of Prince Danilo I (Montenegro, 1895)

Member of the American Philosophical Society (US, 1896)

AIEE Edison Medal (Institute of Electrical and Electronics Engineers, US, 1916)

Grand Cross of the Order of St. Sava (Yugoslavia, 1926)

Cross of the Order of the Yugoslav Crown (Yugoslavia, 1931)

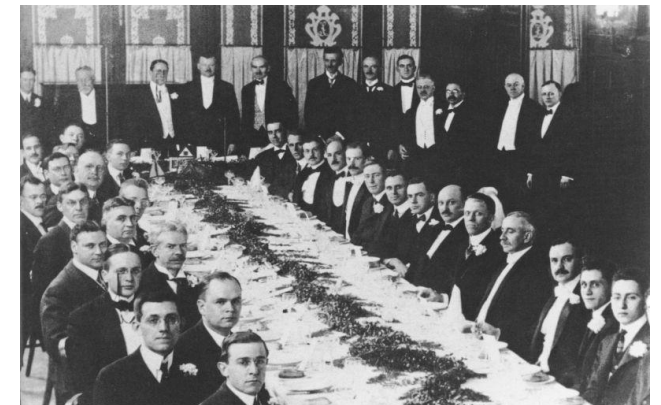
John Scott Medal (Franklin Institute & Philadelphia City Council, US, 1934)

Order of the White Eagle (Yugoslavia, 1936)

Grand Cross of the Order of the White Lion (Czechoslovakia, 1937)

Medal of the University of Paris (Paris, France, 1937)

The Medal of the University St. Clement of Ochrida (Sofia, Bulgaria, 1939)



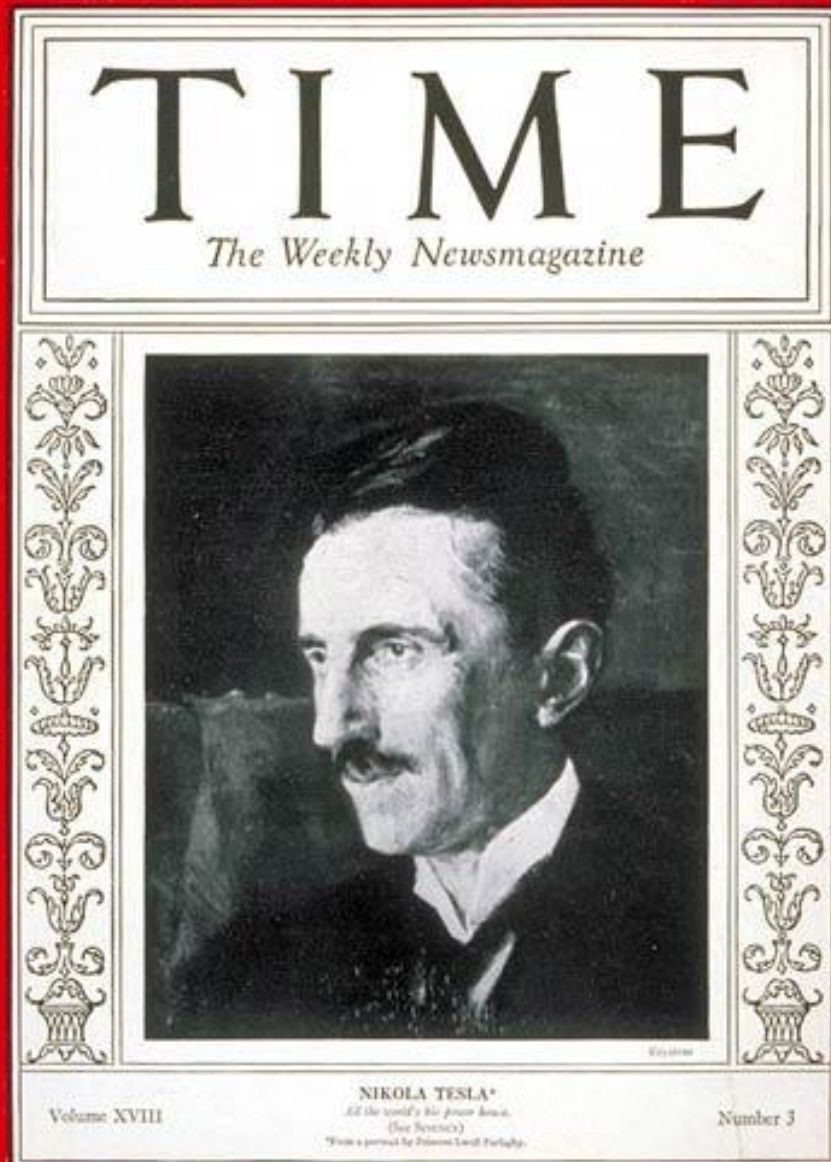
At the 1932 party, Tesla claimed he had invented a motor that would run on cosmic rays. In 1933, at age 77, Tesla told reporters at the event that, after 35 years of work, he was on the verge of producing proof of a new form of energy. He claimed it was a theory of energy that was "violently opposed" to Einsteinian physics and could be tapped with an apparatus that would be cheap to run and last 500 years. He also told reporters he was working on a way to transmit individualized private radio wavelengths, working on breakthroughs in metallurgy, and developing a way to photograph the retina to record thought.

At the 1934 occasion, Tesla told reporters he had designed a superweapon he claimed would end all war. He called it "teleforce", but was usually referred to as his death ray. In 1940, the New York Times gave a range for the ray of 250 miles (400 km), with an expected development cost of US\$2 million (equivalent to \$43.5 million in 2023).



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Tesla lived at the Waldorf Astoria in New York City from 1900 and ran up a large bill. He moved to the St. Regis Hotel in 1922 and followed a pattern from then on of moving to a different hotel every few years and leaving unpaid bills behind.

Tesla walked to the park every day to feed the pigeons. He began feeding them at the window of his hotel room and nursed injured birds back to health. He said that he had been visited by a certain injured white pigeon daily. He spent over \$2,000 (equivalent to \$36,410 in 2023) to care for the bird, including a device he built to support her comfortably while her broken wing and leg healed. Tesla's unpaid bills, as well as complaints about the mess made by pigeons, led to his eviction from St. Regis in 1923. He was also forced to leave the Hotel Pennsylvania in 1930 and the Hotel Governor Clinton in 1934. At one point he also took rooms at the Hotel Marguery. Tesla moved to the Hotel New Yorker in 1934. At this time Westinghouse Electric & Manufacturing Company began paying him \$125 (equivalent to \$2,850 in 2023) per month in addition to paying his rent.

**Tesla on Time magazine
commemorating his 75th birthday**



Room 3327 of the Hotel New Yorker, where Tesla died



In the fall of 1937 at the age of 81, after midnight one night, Tesla left the Hotel New Yorker to make his regular commute to the cathedral and library to feed the pigeons. While crossing a street a couple of blocks from the hotel, Tesla was struck by a moving taxicab and was thrown to the ground. His back was severely wrenched and three of his ribs were broken in the accident. The full extent of his injuries was never known; Tesla refused to consult a doctor, an almost lifelong custom, and never fully recovered.

On 7 January 1943, at the age of 86, Tesla died alone in Room 3327 of the Hotel New Yorker. His body was found by maid Alice Monaghan when she entered Tesla's room, ignoring the "do not disturb" sign that Tesla had placed on his door two days earlier. Assistant medical examiner H.W. Wembley examined the body and ruled that the cause of death had been coronary thrombosis (a type of heart attack).

